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ABSTRACT

A model is presented which incorporates certain features lacking in many schemes: it proceeds in a systematic manner; it addresses the interaction of cognitive processes and instructional task demands; it provides for continuous evaluation and modification; and it deals with measurable behaviors. It is divided into three components adapted from Tuckman and Edwards (1973). The first component, analysis, contains: (1) the determination of postinstructional behaviors, (2) the translation of these behaviors into behavioral objectives, and (3) a specification of a sequence for the presentation of objectives. The second component, synthesis, involves: (1) an analysis of learner competencies and processes, (2) an analysis of task demands, and (3) an analysis of the instructional setting. The outcomes of each of these analyses are integrated into an actual instructional program and along with evaluation and modification they comprise the final component of the model, operation. (DAG)

The Design and Implementation of an Individualized Instructional Program

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The purpose of this article is to describe a procedure for determining an optimal individualized instructional program. The model (see Figure 1) incorporates certain critical features lacking in many contemporary schemes: it proceeds in a systematic manner; it addresses the interaction of cognitive processes and instructional task demands; it provides for continuous evaluation and modification; and it deals with measurable behaviors.

The model is divided into three components (adapted from Tuckman and Edwards, 1973). The first component, analysis, contains the following three activities: (1) the determination of post-instructional behaviors, (2) the translation of these behaviors into behavioral objectives, and (3) a specification of a sequence for the presentation of the objectives. Following analysis is synthesis, which involves: (1) an analysis of learner competencies and processes, (2) an analysis of task demands, and (3) an analysis of the instructional setting. The outcomes of each of these analysis are integrated into an actual instructional program. The instructional program, along with evaluation and modification, comprises the final component of the model, operation.

The remainder of this article details each of these activities.

Insert Figure 1 Here

I. Analysis

1. Specification of Post-Instructional Behaviors

The educational process consists of providing a series of environments that permit a student to acquire new behaviors or modify existing behaviors. Within this context, learning is defined as the exhibition of new behaviors, resulting from instructional influences, which are demonstrated at a satisfactory level of competence and regularity under appropriate circumstances. When learning is viewed in this manner it becomes apparent that the initial step in the implementation of any instructional program must be a determination of the behaviors a student will display if instruction has been successful.

The belief that an instructional program should be initiated by specifying terminal behaviors represents a departure from the typical techniques used in instructional development. The model begins by asking 'What behaviors will indicate that learning has taken place?' as opposed to 'What should we begin teaching?' This approach is based upon the premise that only when terminal behaviors are specified at the onset of instruction can instruc-

tional sequences be designed specifically to aid in the attainment of those behaviors.

Terminal behaviors can be approached on two levels. The first, most abstract, level includes the long-term global goals of education. Attainment of these behaviors is often the product of many years of schooling. Examples of behaviors at this level are:

1. the student displays the fundamental skills of reading and writing
2. the student displays a knowledge of civics
3. the student displays an understanding of astronomical concepts.

Global behaviors are too broad to be successfully translated into short-term instructional programs. As a result, these behaviors must be rewritten as a series of specific behaviors which indicate the terminal performance capabilities of students completing a single instructional unit. For example, the first global behavior above could be divided into specific behaviors such as:

1. Can name and recognize letters of the alphabet.
2. Can write a simple letter or paragraph.
3. Can understand and answer inferential questions.

It is on this level that descriptions of terminal behaviors should be written. The increase in specificity over global behaviors allows a more finite determination of appropriate instructional activities.

Once the terminal behaviors have been determined, it is then necessary to ascertain the cognitive level at which those behaviors occur. This is necessary if the instructional sequence is to contain all the appropriate prerequisite skills. The most applicable description of the levels of cognitive functioning is found in the Taxonomy of Educational Objectives (Bloom, 1956).

The Taxonomy divides the cognitive domain into six levels, ranging from knowledge (the lowest level) to evaluation (the highest level). The characteristics of each level are as follows:

Knowledge refers to the recall of specific or universal facts, the recall of methods or processes, or the recall of patterns, structures, or settings. Behaviors on this level involve little more than 'bringing to mind' presented information.

Comprehension represents the lowest form of understanding. Behaviors on this level require the student to rephrase knowledge accurately or to explain or summarize in his own words.

Application involves the use of abstractions in particular or concrete situations. Student behaviors on this level indicate that past learning can be applied successfully to solve novel problems.

Analysis refers to the ability to break apart a concept or communication into its constituent elements and the ability to indicate the interrelationships of the elements. A behavior on this level involves being able to indicate (a) the organization of a stimulus, (b) the way in which the communication conveyed its effects, and (c) the interrelationship of the communication's parts.

Synthesis is the ability to arrange pieces of elements in such a way as to create a novel pattern or structure. Behaviors on this level indicate that a student can assemble discreet elements to form a unified structure.

Evaluation involves making qualitative or quantative judgements according to a predetermined set of criteria. The student displays evaluation behaviors when he is able to determine the adequacy of a stimulus along selected dimensions.

In sum, the first step of the model requires the determination of post-instructional behaviors along with the cognitive level at which those behaviors will occur. The more clearly defined the terminal behaviors are the more effectively the instructional materials can be chosen and sequenced.

2. Translation of Terminal Behaviors into Behavioral Objectives

A behavioral objective is a statement which specifies a testable condition. An objective, if it is to be useful, must describe a behavior in a manner such that all who read the des-

cription can agree whether or not a student's actions satisfy a predefined criteria. The type of statement required, therefore, must contain the following components: it must contain a statement of performance (usually employing an action verb); it must contain a statement of the conditions under which the performance is to occur; and it must contain a statement against which the performance is to be evaluated. (Mager, 1962) Examples of acceptably and nonacceptably written objectives are shown in Table 1.

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Insert Table 1 Here

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Behavioral objectives are viewed not as a collection of end points in an instructional program but rather as steps in the total learning process. When used in this content, objectives allow an instructor to start with 'what should the curriculum be' as opposed to 'what is the current curricular structure'.

The model requires that the behaviors specified as the outcomes of a successful instructional program be analyzed as to their component skills, with each skill then being rewritten as a behavioral objective. The translation of terminal behaviors into behavioral objectives allows one to readily determine the behaviors relevant to the instructional task.

Additionally, this procedure greatly clarifies the type of learning to be undertaken and the required conditions of learning and subsequent evaluation. An illustration of the translation process is provided in Table 2.

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Insert Table 2 Here

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3. Sequencing of Behavioral Objectives

Structural analysis (Tuckman, 1968) is a technique for specifying the sequential relationships among a set of behavioral objectives. This approach makes possible the specification of a sequence of instructional objectives, that when arranged in a prespecified logical order, maximizes movement from entry into the sequence to the attainment of the final terminal behavior.

Structural analysis is based upon two major premises. First, learning is viewed as a sequential process where the attainment of complex behaviors is dependent upon the acquisition of the prerequisite lower order skills. Second, the establishment of an appropriate sequence is regarded as one of the essential conditions governing learning. (cf. Bloom, 1971; Gagne, 1970)

The importance of determining the sequence of instructional elements lies in the fact that it enables one to avoid omitting essential steps in the acquisition of knowledge. Since each

subordinate skill has been identified as such because it is hypothesized to contribute to the learning of a related higher-order skill it follows that higher-order behaviors will be more readily acquired if the subordinate skills have been learned and are available for recall. The sequence, therefore, identifies the ordered relationship of a set of skills where substantial amounts of positive transfer is expected from lower-order skills to connected ones of a higher position.

This phase of the model requires a determination of the interrelationships of the members in the set of previously defined objectives. A logical sequence for the objectives can be arranged if, for each objective, the following questions are answered:

1. Which objectives in the set must be mastered before this skill can be taught?
2. To which objectives in the set is this skill a prerequisite.
3. Which objectives in the set are not hierarchically related to this skill.

The procedure for determining the interrelationships of objectives is illustrated in Figure 2. An instructional hierarchy is shown in Figure 3.

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Insert Figure 2 Here

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Insert Figure 3 Here

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II. Synthesis

1. Analysis of Learner Competencies and Processes

The majority of students in any classroom have the potential to acquire the terminal behaviors considered to be the desirable products of instruction. It is therefore the responsibility of the instructional planner to determine a procedure by which any student will be able to acquire these behaviors.

The instructional sequence leading to the desired terminal behaviors can be operationalized in two ways. The first method approaches the class as a whole as the recipient of instruction, with all students proceeding at the same pace, on the same materials, at the same

objective level. Carroll(1963), in regard to this method, has pointed out that if the students are normally distributed with respect to aptitude for the subject and all are provided with exactly the same instruction, the end result will be a normal distribution on an appropriate measure of achievement. Furthermore, the relation between aptitude and achievement will be fairly high (approaching a correlation of approximately .70).

While the idea of a normal distribution of performance within any particular classroom has come to be accepted in educational practice, it is necessary to realize that there is nothing sacred about this distribution. As Bloom (1971) has stated, "Education is a purposeful activity, and we seek to have the student's learn what we have to teach. If we are effective in our instruction, the distribution of achievement should be very different from the normal curve. In fact, we may even insist that our educational efforts have been unsuccessful to the extent that the distribution of achievement approximates the normal distribution.". (p.44)

The primary cause of failure for many students results from the fact that they are placed at a level in the instructional sequence for which they have not mastered the prerequisite skills. If the instructional approach is based upon the strategy

of taking into consideration individual differences in learners, quite different learning outcomes occur. When the type and quality of instruction ahd the amount of time available for learning is made appropriate to the characteristics and needs of each student, a majority of students may be expected to achieve mastery of the subject. Further, the relationship between aptitude and achievement approaches zero. (Carroll, 1963)

Effective instructional programs are predicted upon providing instruction specific to the needs of each student. This phase of the model, therefore, requires that a determination be made of each student's competencies, in order that each may be placed at the appropriate level in the instructional sequence. Tests must be administered which provide information on the skills already possessed by a student before he begins an instructional sequence.

The type of tests required in this system are criterion-referenced tests. "A criterion-referenced test is one that is deliberately constructed to yield measurements that are directly interpretable in terms of specified performance standards." (Glaser and Nitko, 1971, p.653) In order to satisfy this definition, criterion-referenced tests must

have the following characteristics (Nitko, 1974):

1. The classes of behaviors that define different achievement levels are specified as clearly as possible before the test is constructed.
2. Each behavior class is defined by a set of test tasks in which the behaviors can be displayed in terms of all their important nuances.
3. Given the classes of behavior have been specified and that the test situations have been defined, a representative sampling plan is designed and used to select the test tasks that will appear on any form of the test.
4. The obtained score must be capable of expressing objectively and meaningfully the individuals performance characteristics in these classes of behavior.

Criterion-referenced tests are therefore constructed to supply information about a student's performance relative to a specified domain of tasks.

The major problem involved in constructing items for criterion-referenced tests is the design of test tasks that are clearly members of the relevant domain. In their ideal form, the tasks to be performed are representative samples of tasks that are the objectives of instruction at a particular stage in the instructional sequence. The reader is directed to: Glaser and Nitko, 1971;

and Davis and Diamond, 1974 for detailed guidelines relating to the construction of test items.

Once the test items have been generated, it is necessary to develop a test procedure that will, as quickly as possible, locate a pupil's performance level at the appropriate position in the instructional sequence. A procedure designed to accomplish this task has been presented by Ferguson (1970).

The procedure attempts to place a student at an objective level in a manner such that if he were tested on all those objectives at that location he would demonstrate mastery, and if he were tested on all those objectives above that location he would demonstrate lack of mastery. Here, mastery is defined as a student making "a sufficient number of correct responses on the sample of test items presented to support the generalization . . . that he has attained the desired, prespecified degree of proficiency with respect to the domain." (Glaser and Nitko, 1971, p.641) Ferguson found that the most effective procedure was to begin testing objectives in the middle of the hierarchy, and then, depending upon the student's responses, test either a higher or lower objective. The determination as to which objective to test next is governed by the criteria presented in Table 3. (adapted from Nitko, 1974).

Insert Table 3 Here

The placement of a student at the proper objective in an instructional sequence is necessary is instruction is to be appropriate to the student's competencies. However, if instruction is to be maximally useful and relevant it is also necessary to determine the underlying processes responsible for incorrect responses on the criterion-referenced tests. Analyses must be performed to ascertain the causes of errors.

An error analysis entails a review of all incorrect items on a test in order to discover patterns of errors. The procedure involves making a determination of the processes used by the student to move from the stimulus (the test question) to the response (the answer to the test question). Error analysis allows instruction to be individualized to the needs of different students operating at the same objective level. An example of an error analysis in mathematics is shown in Table 4.

Insert Table 4 Here

2. Analysis of Materials

Instructional materials are most effective in guiding learning if (1) they are of high quality, and (2) the characteristics of the materials are related to the needs of the learner. As a result, it is necessary for the instructional planner to make an analysis of the strengths and weaknesses of all materials employed. This section describes a framework for performing this analysis.

Tyler and Klein (1974) have presented a series of criteria by which to ascertain the level of quality of any instructional material. The most important are:

Objectives should be specified operationally. This criteria is based upon the premise that it is the behaviors of students that should be the concern of education. It is believed that only a clear conception of desired behaviors allows for the construction of a relevant and appropriate curriculum.

The value of objectives must be substantiated. The product developer must present documentation in regard to the value of

the objectives chosen. This entails defining the basis of objective selection, the relationship of the objectives to the subject area, and the procedure by which the objectives were derived.

Objectives should be consistent with each other. Underlying this recommendation is the belief that consistency is necessary if learners are to consolidate gains in behavior over a period of time. Objectives that are contradictory will result in conflicting behaviors and poor learning.

Learning activities should be directly related to the behavior and content of the specified objectives. The materials must be examined in regard to the appropriateness of activities. This criteria is based upon the belief that the means of learning should be directly rel to the desired terminal behavior.

Learning activities must be arranged so that the behavior of the student is developed. This recommendation is based upon the assumption that the most significant changes in behavior do not occur as a consequence of a few encounters. Rather, there is a need for frequent exposures to appropriate learning activities.

Technical manuals should cite sources of available evidence to document any claims made about effectiveness and efficiency. Product developers must provide information relating not only to the product's studies, but evidence from other carefully documented studies. Evaluative studies should be described in a clear, straightforward manner.

The technical manual must describe in detail the types of behaviors which the teacher is to utilize. Materials may require behaviors of teachers quite different from those they presently possess. New behaviors must be described so that the materials can be effectively utilized.

Once a set of materials have been selected it is then necessary to perform an analysis to determine the point in the instructional sequence at which they are most relevant, applicable, and appropriate. The instructional material used must be that which provides activities maximally related to the objective and desired terminal behavior.

3. Analysis of Instructional Mode

Quality of instruction has typically been defined in terms of good and poor teaching, teacher characteristics, instructional materials and curriculum - all as related to group processes. Instructional planners persist in asking questions of the form:

1. What is the best teacher for the group?
2. What is the best method of instruction for the group?
3. What is the best instructional material for the group?

Clearly, this approach is in opposition to the approach adapted by the model.

The model is founded upon the assumption that individual students may need very different types and qualities of instruction in order to attain a set of desired terminal behaviors. That is, the same content and objectives can be learned by different students as the results of very different types of instruction. There is evidence, for example, that some students learn quite well through independent study while others need highly structured instructional situations (Congreve, 1965). Further, it appears reasonable to expect that some students will need more concrete illustrations and explanations than will others, some will need more examples to get an idea than others, some will need more approval and reinforcement than others, and some may need to have several repetitions of an explanation while others may be able to grasp it on the first presentation (Bloom, 1971).

This phase of the model requires the instructional planner to determine the instructional needs of each student. This is in accordence with Carroll (1963) who defines the quality of instruction in terms of the degree to which the presentation, explanation, and ordering of elements of the task to be learned approach the optimum for a given learner. The diagnosis of a student's instructional needs is a complex process, a discussion of which is beyond the scope of this article. The reader is directed to Bloom, 1971; Glaser and Nitko, 1971; Harris and Sipay, 1975; and Ashlock, 1976 for detailed discussions in this area.

III. Operation

1. Instruction

The implementation of an effective instructional program entails relating the decisions reached in the synthesis phase of the model. The information on learner competencies and processes, materials, and instructional options must be correlated in order to provide an instructional condition appropriate to each specific learner. When correlated correctly, each student will receive an instructional program designed to meet his specific characteristics.

2. Monitoring and Evaluation

The model requires that as a student proceeds within his instructional program his performance be monitored and assessed at established decision points. Achievement measures similar to those used for initial placement must be obtained. This information collected indicates whether a learning criterian has been achieved, and if not, further tells in what respect the criterian performance has not been attained. If appropriately done, teaching, instruction, and testing should all fade into one another.

Testing information is used by the student and teacher to make decisions about future instructional needs. The evaluation can determine one of three courses of action, depending upon the student's performance. First, it can indicate that the objective has been mastered, and that the student is ready to proceed to the next level. Second, it can indicate that learning is proceeding but incomplete, and additional time and instructional reinforcement is needed. Finally,

it may indicate that no learning has taken place, and a reanalysis of student placement, materials, and instructional mode is needed. This decision-making procedure is illustrated in Figure 4 .

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Insert Figure 4 Here

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Summary

The instructional model presented is an attempt to set forth a set of general requirements governing the creation of an effective instructional program. However, the success of any model is limited by certain constraints. These include: the extent to which proposed learning hierarchies are psychologically real; the extent to which individual differences in ability and learning characteristics are accurately diagnosed; and the extent to which alternative instructional techniques and educational experiences are developed which are adaptive to the individual characteristics of each learner. The success of any program is directly related to the extent to which these criteria are satisfied.

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ANALYSIS:

DETERMINATION OF POST-INSTRUCTIONAL BEHAVIORS

Description of Behaviors

Description of Cognitive Level

TRANSLATION OF BEHAVIORS

Analysis of Component Skills

Write Skills as Behavioral Objectives

SEQUENCING OF OBJECTIVES

Determine Interrelationships

Place Objectives in Hierarchical Order

SYNTHESIS:

ANALYSIS OF LEARNER COMPETENCIES

Determine Entry Level

Determine Processes

ANALYSIS OF MATERIALS

Determine Quality

Determine Relevance

ANALYSIS OF INSTRUCTION

Determine Quality

Determine Relevance

OPERATION:

INTEGRATION OF INFORMATION

Enact Instructional Program

EVALUATION

Carry out Monitoring Activities

REVISION

Modify

Mastery- Begin New Sequence

Continue

Figure 1. A Model for an Optimal Individualized Instructional Program

ACCEPTABLY WRITTEN BEHAVIORAL OBJECTIVES

1. Given a set of sentences containing uncapitalized nouns, the student will correctly identify all nouns that should be capitalized.

2. Given a linear algebraic equation with one unknown, the student will be able to correctly solve for the unknown without the aid of tables or calculators.

3. When given the opportunity to display a piece of classwork, the student will give evidence of positive self-concept be voluntarily posting his work.

4. The learner will show his ability to write a paragraph of 100 words or less on any topic selected from the lists on page 37 or 65 of the text. The paragraph must meet the five standards discussed in class. The writing must be done during one class period.

5. The student will discriminate between simple and complex sentences by separating a given set of illustrative sentences into these two categories with 90% accuracy.

UNACCEPABLY WRITTEN BEHAVIORAL OBJECTIVES

1. The student will construct an instrument employing systematic programming for recording observations of teaching activities. (No standards are provided.)

2. To appreciate various cultures of the world and to understand his responsibilities and opportunity as a citizen of the worl living in a democracy. (The learner is not designated; no standards are provided; the verb is ambiguous.)

3. The student will acquire basic skills and attitudes which enable him to develop an appreciation of cultural values. (Verb is ambiguous; no standards are provided.)

4. To know five principles for judging paintings. (The learner is not designated; no standards are provided; verb is ambiguous.)

5. The student will reveal his knowledge of the Constitution. (Verb is ambiguous;

no standards are provided.)

Table 1. Examples of Acceptably and Unacceptably Written Behavioral Objectives

Skill	Objective
1. Find the area of a triangle	1. The student willl solve a problem of computation of the area of a triangle, given its altitude and base as well as the appropriate formula.
2. Solve equations containing two unknowns	2. The student will solve nine out of ten equations containing two unknowns. The problems must be solved in ten minutes.
3. Read new one-syllable words	3. The student will be able to read correctly new one-syllable words composed entirely of letter sounds included in previous reading instruction, given such new words in printed form.
4. Identify peninsulas	4. The student will be able to identify peninsulas, given a map containing peninsulas and other land masses resembling peninsulas.

Table 2. An Illustration of the Translation of Desired Skills into Behavioral Objectives

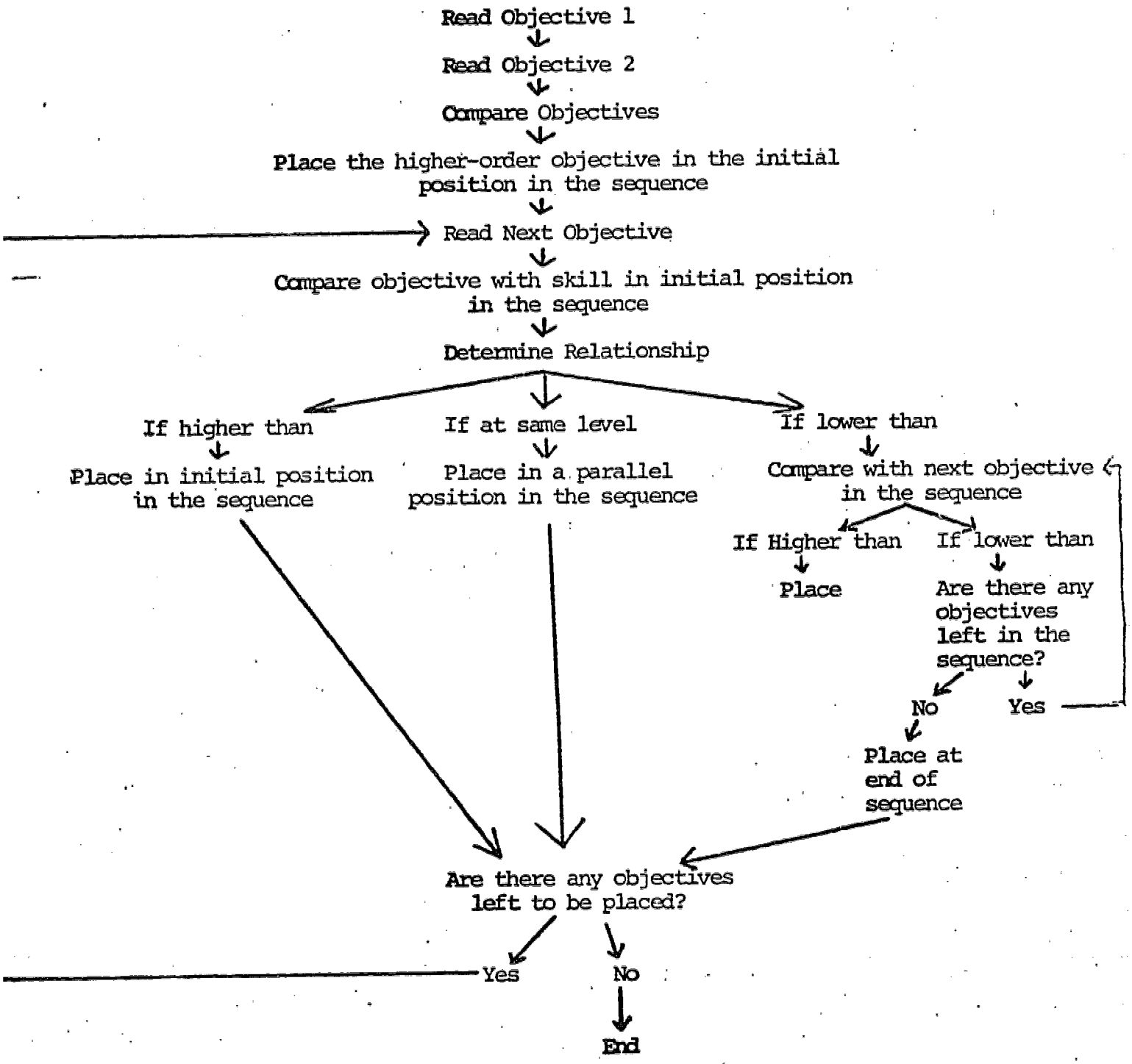

Figure 2. A Program for Determining the Sequential Relationships of a set of Behavioral Objectives

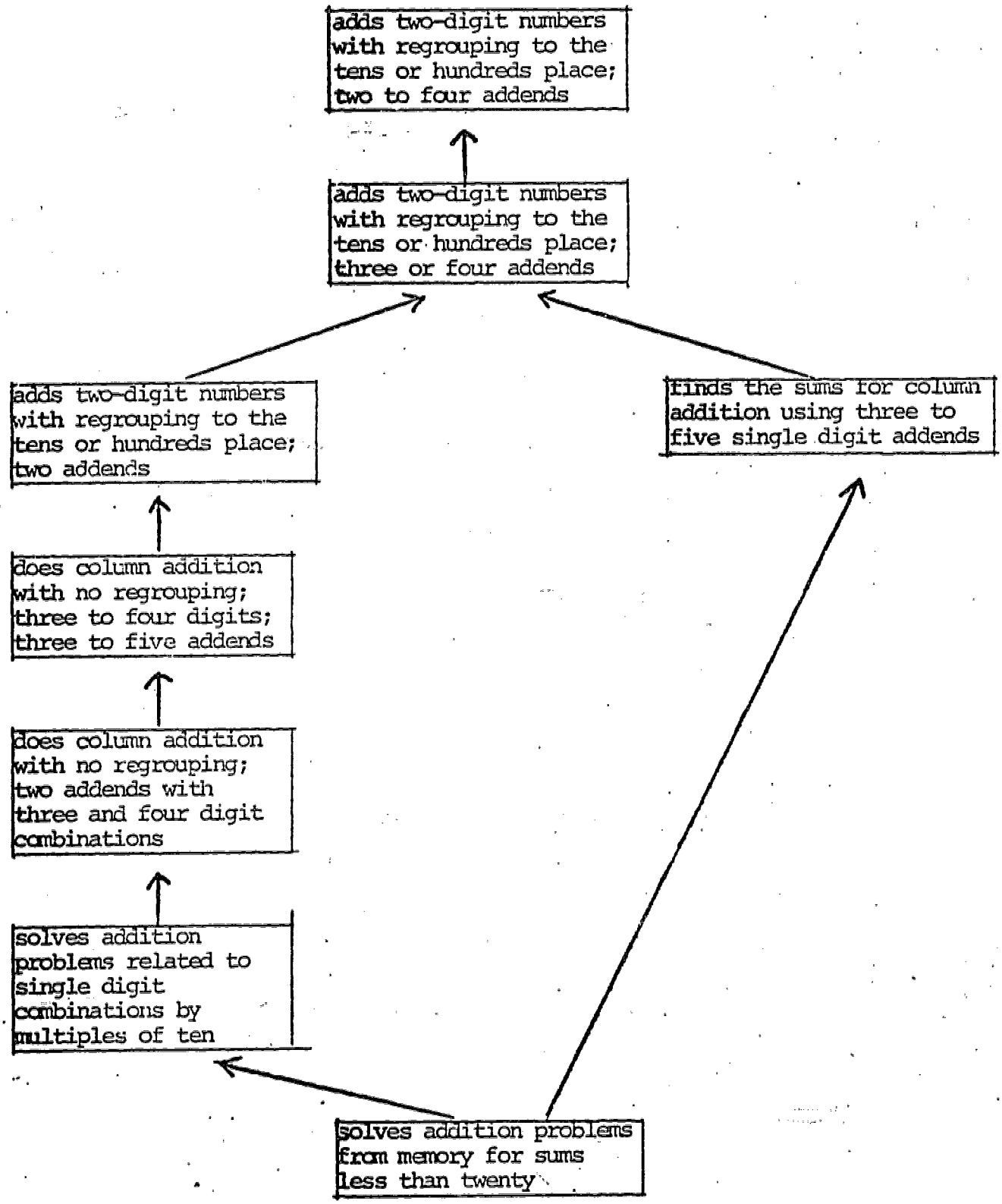

Figure 3. An Instructional Hierarcy in Mathematics (adapted from Ferguson, 1970)

Performance	Level of Performance	Next Test Level
Mastery	Very few or no errors; No weaknesses displayed	Test highest untested skill in sequence
	Some difficulty on tasks; Minimal number of correct responses	Test skill midway between this skill and highest skill in sequence
Nonmastery	Some correct answers; Rudimentary understanding displayed	Test skill midway between this skill and lowest skill in sequence
	Very few or no correct answers	Test lowest untested skill in sequence

Table 3. Criteria for Determining a Test Level

PROBLEM SET 1

Student A	74	35	67	56
	+56	+92	+18	+97
	1210	127	715	1413
Student B	74	35	67	56
	+56	+92	+18	+97
	111	19	715	117

Results of Error Analysis:

Student A -- adds and records total of ones place then adds and records total of tens place

Student B -- adds in reverse order; adds tens place, puts down figure in tens place and carries ones to ones place, adds ones and puts down sum

PROBLEM SET 2

Student C	27	18	24
	x4	x3	x5
	88	34	100
Student D	27	18	24
	x4	x3	x5
	828	324	816

Results of Error Analysis:

Student C -- does not carry; multiplies ones place, finds product, writes down number of in ones position of product, multiplies tens place, writes down product

Student D — multiplies and records product of ones place then multiplies and records product of tens place

Table 4. Error Analysis in Mathematics

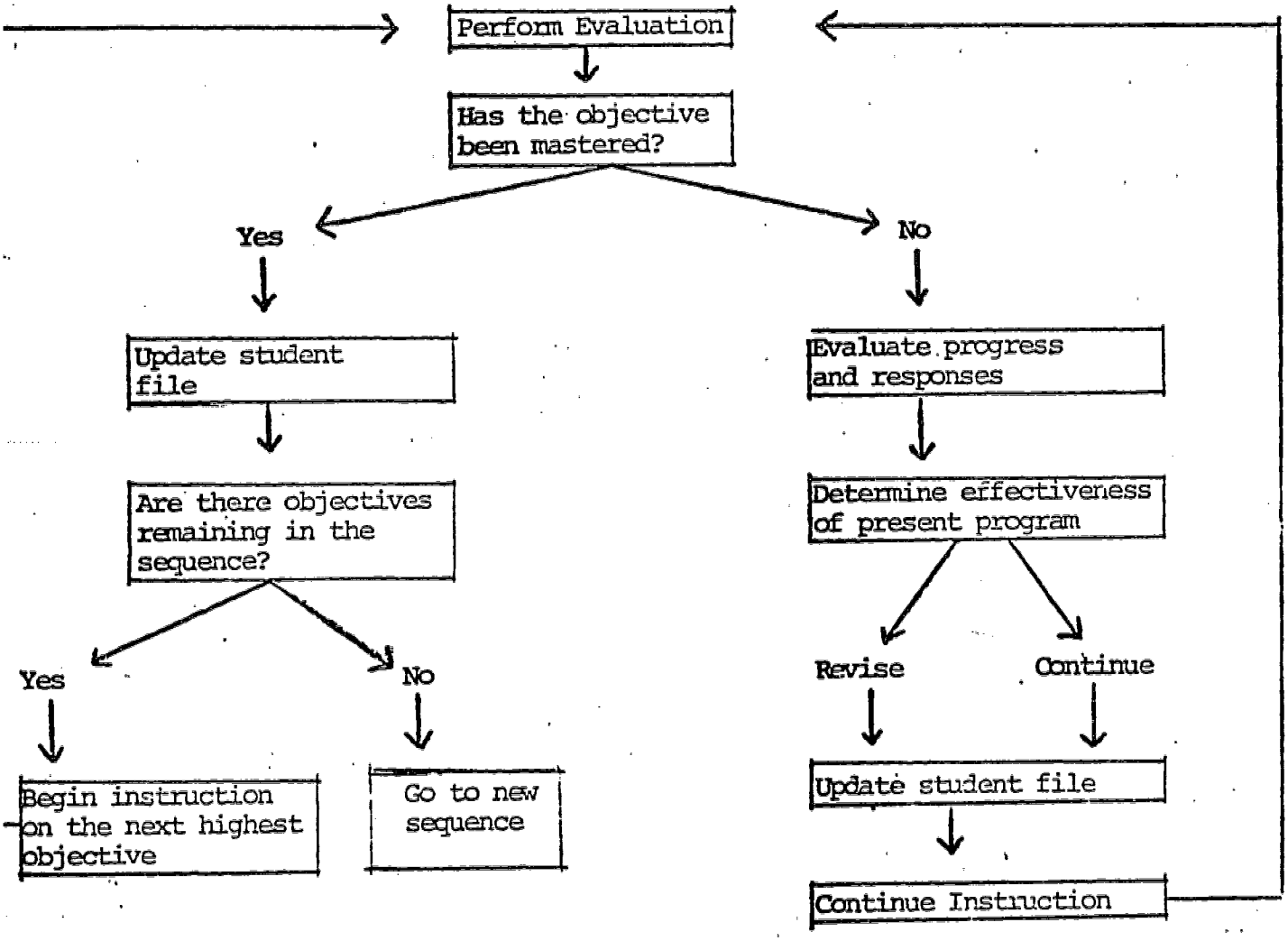

Figure 4. Monitoring and Evaluation in the Instructional Program